Title: **HIGH CAPACITY GLOBE VALVE**

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HIGH CAPACITY GLOBE VALVE

BACKGROUND OF THE INVENTION

Technical Field of the Invention

The present invention relates to high capacity valves, and more particularly to a globe valve configured to reduce flow losses and increase fluid flows therethrough.

Description of Related Art

In a globe valve, flow between a first fluid passage and a second fluid passage is controlled by a plug movable within a tubular throttling cage. Fluid flowing from the first passage to the second passage flows into the throttling cage through an open end, and out of the throttling cage through a plurality of radially oriented flow ports. Alternately, fluid flowing from the second passage to the first flows into the throttling cage through the radial flow ports and out the open end to the first passage. In either case, the plug is movable to selectively cover the flow ports, thereby restricting flow through the throttling cage and the valve.

The flow path through a globe valve is convoluted. In an example where fluid is flowing from the first passage to the second, fluid passes through the open end and into the throttling cage about its axis. Thereafter, the flow must be diverted 90° to exit through the radially oriented flow ports. Flow out through the radially oriented flow ports exits in all directions (360°) and is collected and directed towards a single passage. Thus, a portion of the flow exiting the radially oriented flow ports is diverted as much as 180° to flow around the interior of the valve to the passage. The directional changes are exacerbated in an inline configuration where the valve inlet and outlet are on a common flow axis, because the throttling cage is positioned in perpendicular relation to the common flow axis. As a result, the flow must be diverted an additional 90° to flow through the open end of the throttling cage. Further, the radial flow ports may not be vertically aligned with the outlet, and thus the flow

between the second passage and the flow ports must be diverted to a common axis.

The convoluted flow causes flow losses in areas of the valve that are not controlled by the throttling cage and plug. Not only do the losses limit the overall flow efficiency of the valve, but because they are independent of the flow throttling, the losses impact the characteristics of the throttling control. In other words, as the flow rate increases the total flow loss through the valve becomes more a function of flow rate and less a function of the amount of the flow port covered by the plug.

Prior attempts to reduce flow losses have included increasing the size of the valve body and the fluid ports through which the fluid flows. Unfortunately, larger components such as a larger valve body and a larger throttling cage and plug that would result from the larger fluid ports, also increase the weight and cost of the valve. Further, such larger components also require stronger and more expensive mechanisms, for example the mechanism on which the plug reciprocates. It is preferable that a valve conform to commercially standardized installation dimensions. These dimensions limit the extent to which the size of the valve body and other components can be increased.

Therefore, there is a need for a globe valve that has reduced flow losses, especially at high flow rates, that is comparable in size, weight, and cost to other globe valves.

SUMMARY OF THE INVENTION

The present invention is drawn to a globe valve with refinements that reduce flow losses and increase maximum fluid flows therethrough. The valve has a flow body defining an interior cavity in communication with a first fluid passage and a second fluid passage. The volume of the cavity is substantially equally distributed about a central axis. A tubular throttling cage resides in the cavity. The throttling cage has an open end in communication with the first passage and a plurality of flow ports arranged about a perimeter of the throttling cage. Fluid can flow between the first fluid passage and the

second fluid passage through the throttling cage. The longitudinal axis of the throttling cage is positioned offset from the central axis of the cavity. A plug is closely received in the throttling cage and movable about the longitudinal axis to selectively cover the flow ports thereby restricting flow between the first fluid passage and the second fluid passage. At least one of the flow ports facing the second fluid passage can be larger than at least one or all of the other flow ports. The flow ports can be angled towards the second fluid passage. The flow ports can pass substantially straight through the throttling cage.

An advantage of the invention is that the offset throttling cage allows more annular volume between the throttling cage and the cavity walls in which to more gradually expand or contract flows through the throttling cage. This more gradual expansion or contraction reduces fluid separation from the cavity walls and turbulent flow mixing that causes fluid drag.

Another advantage of the invention is that the angled flow ports reduce inertial flow losses as the flow impinges on the cavity wall, because the flow directional changes within the valve are made more gradually.

Another advantage of the invention is that the flow ports can pass straight through the throttling cage and are thus less expensive to manufacture than curved flow ports and require a thinner throttling cage wall thickness to achieve the same directional change.

These and other advantages will be apparent from the following detailed description with reference to the following drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Various objects and advantages of the invention will become apparent and more readily appreciated from the following description of the presently preferred exemplary embodiments, taken in conjunction with the accompanying drawings of which:

FIG. 1 is a side cross-sectional view of a globe valve constructed in accordance with the invention; and

FIG. 2 is a top cross-sectional view of a globe valve constructed in accordance with the invention.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS OF THE INVENTION

Referring first to FIG. 1, a globe valve 10 constructed in accordance with the invention has a flow body 12. Flow body 12 defines an interior cavity 14 in communication with an first fluid passage 16 and a second fluid passage 18. In the exemplary embodiment of FIG. 1, the first fluid passage 16 intersects a bottom of the cavity 14 near its center and the second fluid passage 18 intersects a side wall of the cavity 14. The interior of flow body 12 is contoured, so that fluid flows smoothly between the first fluid passage 16 and the second fluid passage 18. Further, the flow body 12 depicted in FIG. 1 is that of an inline configuration where, at opposite ends of the valve 10, the first fluid passage 16 and the second fluid passage 18 are substantially centered about the same axis A1. Fluid can travel through the valve 10 in either direction, from the first fluid passage 16 to the second fluid passage 18 or from the second fluid passage 18 to the first fluid passage. However, the valve 10 is most effective when the first fluid passage 16 is an inlet and the second fluid passage 18 is an outlet. Although the concepts are described herein with reference to an inline configuration globe valve, the concepts are applicable to many other various configurations of globe valves.

The interior cavity 14 contains a tubular throttling cage 20 with a longitudinal axis A2 that is substantially perpendicular to the axis A1. The throttling cage 20 concentrically receives and guides a throttling plug 22 for movement of the plug 22 along the longitudinal axis A2. Plug 22 depends from a reciprocating stem 24 extending downward through an upper housing 26 (or bonnet) over the cavity 14. Fluid flows through an open end 28 of the cage 20, and also through a plurality of radially or laterally oriented fluid ports 30 arranged about its perimeter (see FIG. 2). Thus, if fluid enters through the first fluid passage 16, it will flow up through the open end 28 into the cage 20, out through the fluid ports 30 into the cavity 14, and out through the second

fluid passage 18. Alternately, fluid flowing from the second fluid passage 18 to the first fluid passage 16 will flow from the second fluid passage 18 through the fluid ports 30 and into the throttling cage 20, then through the open end 28 to the first fluid passage 16. In one exemplary embodiment, the throttling cage 20 has a substantially cylindrical cross-section, and the plug 22 has a circular profile that fits closely within the inner diameter of the cage 20.

The plug 22 throttles flow through the throttling cage 20 by selectively covering a portion of the ports 30 thereby reducing the available area through which fluid can flow. Thus, the maximum flow through the valve 10 is achieved when the plug 22 is fully retracted (see FIG. 1) to cover the least, or no, amount of the flow ports 30. The plug 22 may be configured to seal to the open end 28 of the throttling cage 20 or to the flow body 12 when fully extended to stop substantially all of the flow into the throttling cage 20 and through the valve 10. The throttling cage 20 can also be sealed to the flow body 12, so that substantially all of the flow through the valve 10 passes through the throttling cage 20. In the exemplary embodiment of FIG. 1, a seal 32 is provided at the bottom of the cavity 14 on the flow body 12 that seals the throttling cage 20 to the flow body 12 and enables the plug 22 to seal with the throttling cage 20.

Referring to FIG. 2, the globe valve 10 constructed in accordance with the invention has several improvements to minimize restrictions to flow in the valve. The volume of the cavity 14 is substantially equally distributed about a central axis A3 that is substantially perpendicular to the axis A1. The longitudinal axis A2 of the throttling cage 20 is offset from the central axis A3 away from the second fluid passage 18. As a result, the annular volume of the cavity 14 between the throttling cage 20 and the flow body 12 increases from an area of least annular volume adjacent the throttling cage 20 opposite the second fluid passage 18 to an area of maximum annular volume in proximity to the second fluid passage 18. This additional annular volume enables fluid flows between the throttling cage 20 and the second fluid passage 18 to more gradually expand or contract, depending on the flow direction, than if the throttling cage 20 was centered in the cavity 14. Thus, as

fluid flows from the first fluid passage 16 to the second fluid passage 18 and is restricted by the throttling cage 20, for example by the flow ports 30, the flow can gradually expand as it passes into the second fluid passage 18. Alternately, as fluid flows from the second fluid passage 18 towards the first fluid passage 16, the flow can gradually contract to pass through the restriction of the throttling cage 20. The gradual fluid expansion or contraction reduces the tendency of the fluid flow to separate from the cavity 14 walls and the resulting turbulent flow mixing that causes increased resistance to fluid flow through the valve 10.

The fluid ports 30 are angled with respect to radii of the cavity 14 (or the throttling cage 20), such that fluid exiting the ports 30 impinges on the cavity 14 walls at an angle other than perpendicular to the wall surface. Further, the ports 30 are angled towards the second fluid passage 18 to direct flow from within the throttling cage 20 towards the second fluid passage 18, or flow from the second passage 16 into the throttling cage 20, thereby contributing to the directional change necessary to route the flow through the throttling cage 20. In an exemplary embodiment, the fluid ports 30 on one side of the throttling cage 20 are a mirror image of those on the other side. Also, the fluid ports 30 furthest from the second passage 16 are oriented to distribute fluid evenly to either side of the cavity 14. The angled fluid ports 30 reduce inertial fluid losses as the fluid impacts the cavity 14 wall, because the directional change is made gradually.

In an exemplary embodiment, the fluid ports 30 are straight passages without curvature. Thus, the ports 30 pass substantially straight through the wall of the throttling cage 20. Also, the walls 31 of the ports 30 do not have to be parallel, so for example as in FIG. 2, two opposing walls 31 of a single port 30 could be angled differently with respect to the radius of the throttling body. Such a straight through design is easy to manufacture, and does not require as thick of a wall in the throttling cage 20 as is required for a curved port to achieve the same flow diversion. However, curved and other configurations of fluid ports 30 are within the scope of the invention.

The fluid port 30a nearest the second fluid passage 18 is larger than other fluid ports 30 and oriented towards the second fluid passage 18 to maximize the amount of flow that can flow directly between the second fluid passage 18 and the interior of the throttling cage 20 without directional changes. Opposite the forward fluid port 30a is a flow splitter 34. The flow splitter 34 is a generally triangular portion of the throttling cage 20 wall defined by two adjacent fluid ports 30b and 30c. A corner of the triangular shape 36 helps to split the flow exiting the upstream side of the throttling cage 20 and begin the 180° directional change that is required for the flow exiting the rear of the throttling cage 20. This flow would otherwise impinge on the wall of the cavity 14, thus the flow splitter 34 helps to reduce flow momentum losses as the fluid changes direction and reduces turbulent flow mixing.

Although several exemplary embodiments of the methods and systems of the invention have been illustrated in the accompanying drawings and described in the foregoing description, it will be understood that the invention is not limited to the embodiments disclosed, but is capable of numerous rearrangements, modifications and substations without departing from the spirit and scope of the invention as defined in the following claims.